Return to Rongelap

LIVERMORE scientists are at the forefront of an extensive 30-year effort to return the native population of Rongelap Atoll in the Marshall Islands to their home island. The population was displaced to a neighboring atoll following radioactive fallout from a U.S. nuclear test detonated in 1954 on Bikini Atoll, approximately 112 kilometers west of Rongelap. In 1957, the U.S. government resettled the islanders back on Rongelap. However, in 1985, they relocated to Mejetto Island on Kwajalein Atoll because of the community's concerns about lingering radioactive contamination and its potential health effects.

Radioecologist Terry Hamilton of Livermore's Physical and Life Sciences Directorate leads the restoration and resettlement effort through the Laboratory's Marshall Islands Dose Assessment and Radioecology Program. The program, which is under the Department of Energy's (DOE's) Office of Health, Safety, and Security, develops comprehensive assessments of radiological conditions on the island, recommends remediation activities for contaminated sites, and assesses the effectiveness of those efforts.

In recent years, as a part of this ongoing effort, Livermore scientist Bill Robison and Hamilton have calculated the expected radiation doses for people resettling on Bikini, Enjebi (Enewetak Atoll), and Rongelap islands. The results have shown that cesium-137, which has a half-life of 30 years, would account for 98 percent of the total radiation doses to the returning population, and specific steps have been identified to significantly reduce the dosage. Cesium-137 is one of the long-lasting radionuclides generated from nuclear testing.

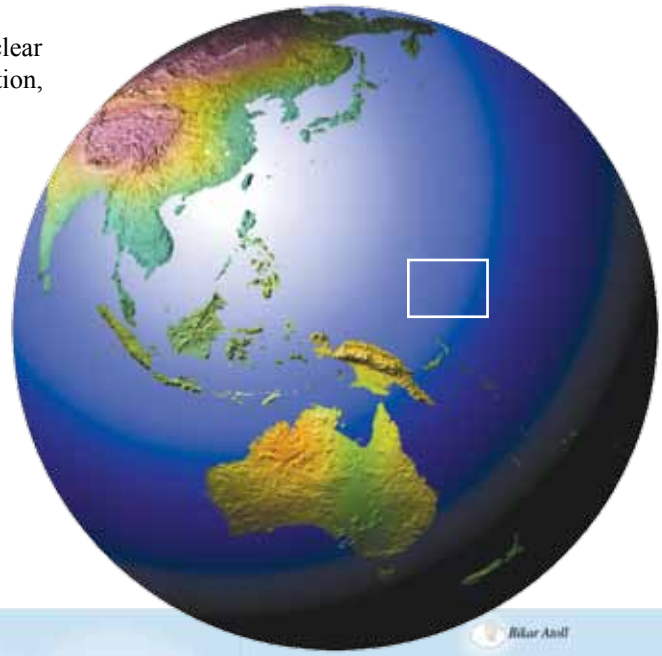
"People could possibly resettle on Bikini based on the data we're getting from the remediation and resettlement effort at Rongelap," Hamilton says. Bikini and Enewetak atolls were ground zero for the U.S. nuclear tests. "If this remediation strategy is pursued, we estimate that the natural background dose combined with the nuclear-test-related dose on the islands of Bikini, Enjebi, and Rongelap would be less than the typical background dose in the United States or Europe."

Times Past

Immediately following World War II, the U.S. created a Joint Task Force to develop a nuclear weapons testing program. The task force examined several possible locations, including the Atlantic Ocean, the Caribbean, and the Central Pacific. The coral atolls in the northern Marshall Islands had many advantages—stable weather conditions, few inhabitants to relocate, and isolation with hundreds of kilometers of open ocean, where trade winds were likely to disperse radioactive fallout.

Between 1945 and 1958, 67 nuclear tests were conducted on Bikini and Enewetak atolls and adjacent regions within the

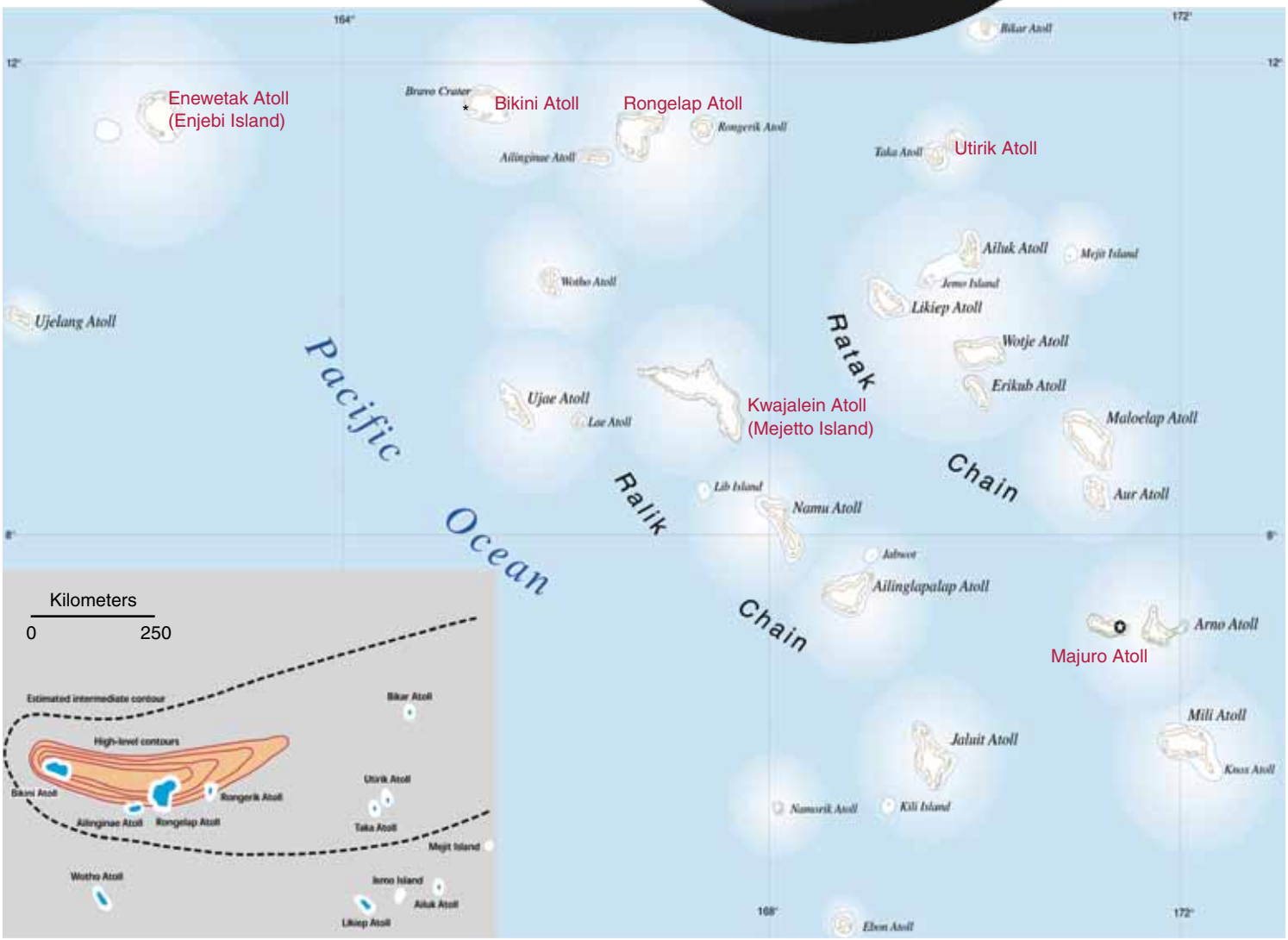
Republic of the Marshall Islands. The U.S. conducted 24 nuclear tests at Bikini Atoll with a total yield, or energy from detonation, of 76.8 megatons. The hydrogen bomb device detonated on March 1, 1954, at Bikini Atoll—dubbed Castle Bravo—had an estimated yield of 15 megatons. Castle Bravo was significantly more powerful than scientists had predicted, and it was the primary source of radioactive contamination of Bikini, Rongelap, and Utirik atolls. The resulting debris cloud rose over 15,000 meters high, which led to widespread fallout contamination over inhabited islands.



Following detonation of the 1954 Castle Bravo nuclear test on Bikini Atoll, high-altitude winds carried the debris cloud toward Rongelap Atoll. The radioactive fallout pattern is shown in the lower left inset.

Restoring Health to the Islands

The first in a series of long-term remediation experiments began on Bikini Island during the late 1980s to evaluate potential techniques to reduce the uptake of cesium-137 into plants. Researchers found that adding



potassium fertilizer to agricultural fields reduces the cesium-137 concentration in edible fruits by about 95 percent. They also found that potassium increases the growth rate and productivity of some food crops with no adverse environmental impacts.

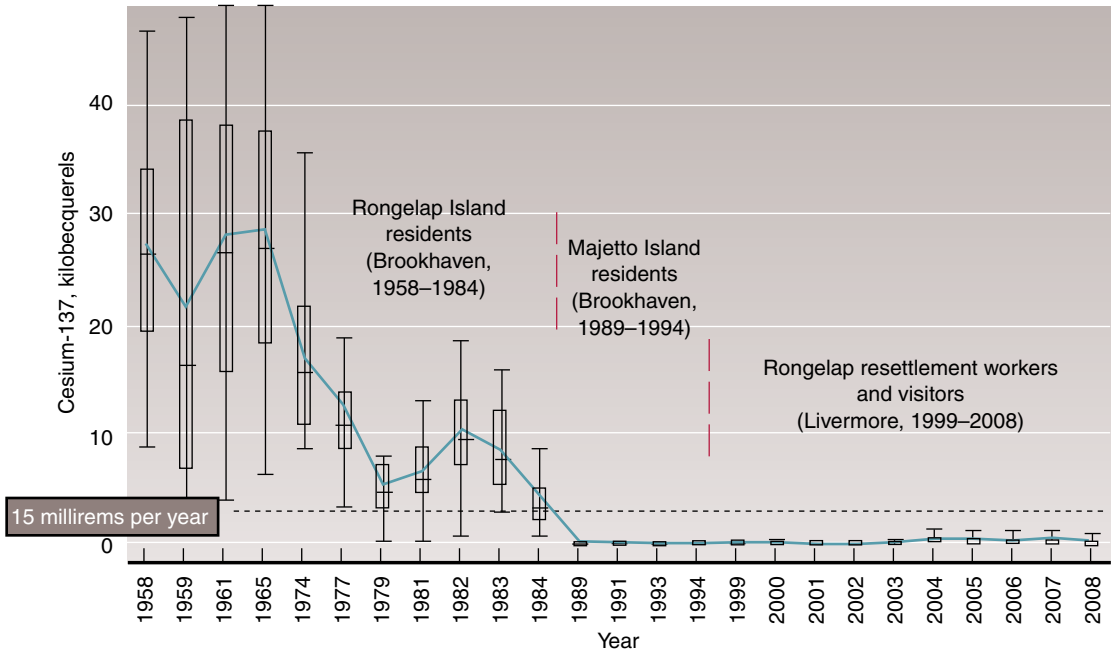
On Bikini Island, a large-plate lysimeter collects water from soils to determine the concentration of radionuclide contaminants present in that water. Lysimeter studies are providing data on the rainfall removal rate of cesium-137 from surface soils.

The team's research showed that rain transports a portion of the cesium-137 below ground, where it eventually mixes with ocean water. The rate of this loss process is much faster than the loss by radioactive decay.

According to Hamilton, a combination of treating crops with potassium and removing the top 25 centimeters of soil around houses and community buildings prior to new construction is a viable remediation strategy for resettlement. The replacement of contaminated surface soil around the village and housing areas with crushed-coral fill helps minimize external exposure rates in areas where people spend most of their time. Successful resettlement efforts on Rongelap could lead to similar efforts for the northern Marshall Islands of Bikini Atoll and affected islands at Enewetak Atoll.

In 1996, a resettlement agreement between the U.S. and the Rongelap Atoll Local Government was approved. Under this agreement, DOE is tasked with formulating a plan to monitor the effectiveness of cleanup activities and develop expertise in radiological protection monitoring among local residents. To this end, DOE is encouraging the local atoll communities to assume shared responsibilities for implementing radiation surveillance monitoring programs for resettled and resettling populations in the northern Marshall Islands. Together, DOE and local atoll governments have developed individual radiological surveillance programs in whole-body counting and plutonium urinalysis to track and assess radiological doses from residual fallout contamination.

This graph shows the history of internally deposited cesium-137 in adult males from Rongelap Island from 1958 to 1994 and for resettlement workers and visitors on the island from 1999 to 2008 as measured by Brookhaven and Lawrence Livermore national laboratories. In 1985, the people of Rongelap re-evacuated to Mejetto Island on Kwajalein Atoll.



Whole-Body Counting

Permanent whole-body counting facilities have been established on Enewetak, Rongelap, and Majuro islands. They are operated and maintained by Marshallese technicians with ongoing technical support from Livermore scientists. "These facilities comprise the largest per-capita whole-body counting program in the world for members of the public," says Hamilton. "To date, we've counted about 5 percent of the Marshallese population and more than 3,000 people are in our database."

The whole-body counting systems contain large-volume sodium iodide radiation detectors that measure gamma rays emitted from radionuclides deposited in the body. Program participants sit in an oversized chair for about 15 minutes, while the detector system noninvasively scans most of their body and all of their internal organs for high-energy gamma-emitting radionuclides, such as cesium-137 and cobalt-60. Specially designed computer software converts the measurements into an annual effective dose, and participants receive the report immediately following the test.

Residents in the northern Marshall Islands are primarily exposed to residual fallout contamination by ingesting cesium-137 contained in locally grown foods, such as coconut. Whole-body counting provides a direct measure of cesium-137 in the body. Residents who receive a whole-body count showing the presence of cesium-137 can make informed decisions about their eating habits or lifestyle based on what is considered a "safe" or acceptable health risk. The annual safe dose accepted by the Marshall Islands Nuclear Claims Tribunal is 0.15 millisieverts (15 millirems) per year. This number is based on guidance from the U.S. Environmental Protection Agency. For comparison, the dose from a chest x ray is 0.10 millisieverts (10 millirems) and from a panoramic dental x ray is 0.01 millisieverts (1 millirem).

The whole-body counting program on Rongelap provides insight into the range of exposures likely to be seen in a hypothetical resident population. "What is very clear is that levels of internally deposited cesium-137 measured in resettlement workers from 1999 to 2008 are more similar to levels observed on Mejetto from 1989 to 1993 than for the resident male population living on Rongelap during the 1980s," says Hamilton.

Monitoring Plutonium with CAMS

Radioactive by-products of nuclear explosions, including plutonium, end up being deposited on the ground and residing in the soil. The primary way humans are exposed to plutonium is through inhalation of contaminated dust particles. Inhaled or ingested plutonium can eventually end up in various organs, including the lungs, liver, and bone, resulting in continuous exposure to alpha-particle radiation. Plutonium is a concern to the Marshallese people because of its long half-life (24,000 years) and persistence both in the environment and in the human body.

Plutonium urinalysis monitoring is a highly sensitive in vitro measurement technique used to determine the amount of plutonium in human urine, from which the total amount of plutonium in the body can be extrapolated. Livermore scientists developed a plutonium bioassay monitoring program for resettlement workers on Rongelap. The bioassay program included assessments of 115 resettlement workers. Many of the workers on Rongelap who provided bioassay samples were exposed to potentially high resuspension conditions associated with soil remediation. People simply living on the island would be expected to have less exposure.

Locally trained technicians collected urine samples from resettlement workers, which were sent to Livermore's Center for Accelerator Mass Spectrometry (CAMS) for analysis. At CAMS, scientists analyzed the urine samples by counting the number of plutonium atoms contained in each sample. "Under the Marshall Islands Radiological Surveillance Program, we have developed a new state-of-the-art technology for measuring the amount of plutonium in urine based on accelerator mass spectrometry," says Hamilton, who leads the effort at CAMS. "The fact that none of the workers participating in the bioassay monitoring program have elevated levels of plutonium in their urine suggests that plutonium exposure is unlikely to be an issue of concern associated with resettlement of Rongelap Island."

A Paradise Restored

"The potential social and cultural benefits of resettlement coupled with the availability of clean water and spacious housing on Rongelap, as well as access to a rich, thriving atoll ecosystem, will likely improve the general wellness of the community," says Hamilton. Information from the individual and environmental radiological surveillance programs will help Hamilton and his team provide high-quality measurement data and reliable dose assessments. It will also help build a strong technical and scientific foundation to sustain resettlement of the affected atolls.

"There is a strong interplay between science and people," says Hamilton. "Communication is the most difficult aspect of this effort, but it is also the most rewarding. I hope that we see full resettlement of Rongelap and other affected atolls in my lifetime."

—Kristen Light

Key Words: Castle Bravo nuclear test, Center for Accelerator Mass Spectrometry (CAMS), cesium-137, Marshall Islands, plutonium urinalysis, potassium fertilizer, radiation dose, radioactive fallout, Rongelap Atoll Local Government, whole-body counting.

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